Space Weather Technical Forecast

Issued on Thursday, 13 October 2022 at 13:16 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Decreasing chance of M-class flares. Active electron Fluence.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate, with a long period M1.5 flare observed from AR3112 (Esi/Beta-Gamma) along with a couple of C-flares. AR3112 has shown some simplification as it approaches the western limb, and losing its easternmost spots. AR3116 (Hsx/alpha) to the north of this region, remains a simple unipolar region, whilst a further small unnumbered spot appears to have emerged to the south of it. C-flaring was also observed from AR3119 Dai/Beta, also in the northwest quadrant, although this is a smaller and magnetically simpler region than AR3112, and also in decline. There are a total of four numbered sunspot regions on the disc, with a new region AR3121, recently being numbered in the northeast disc, however this remains small and simple. There are also a number of filaments on the Earth-facing disc, one of which erupted in the southern centre disc around 13/0650 UTC. The CME that followed has yet to be fully assessed, and is likely heading south of Earth's orbit, however given its centre disc location may have an Earth-directed component.

Solar Wind / Geomagnetic Activity: The solar wind speed, as observed at L1, erratically eased from 350 km/s to 300 km/s as Earth remained within the ambient slow wind. Density was below average. The total IMF strength, Bt, has been weak at below 5nT, with the north-south component, Bz predominately negative but also weak. The phi angle was initially variable but became mostly positive (away from the Sun) from, 12/2315. Geomagnetic activity was Quiet (Kp 0-2).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES16, has been at background levels. High energy electron flux (greater than 2MeV) was predominately at high levels, peaking at 6216 pfu at 12/1420UTC. The associated 24-hour fluence has been above the Active (1e8 integrated pfu) threshold throughout but with a gradual declining trend since midnight. The 13/0000 UTC observation was 2.62e8 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is forecast to be Low to Moderate with an ongoing but decreasing chance of M-flares, primarily from AR3112 but potentially from AR3119 or other smaller regions on the disc.

Solar Wind / Geomagnetic Activity: There is a CME that is likely to miss Earth day 2 (14th), but has a small chance of giving a peripheral influence as it passes. Otherwise Earth will likely see background winds persisting through much of the period, before the arrival of the fast wind of CH32/- late day 2 or more likely day 3 (15th). Geomagnetic activity will be mostly Quiet with a chance of isolated Unsettled (Kp 0-3) intervals, perhaps increasing to Active (Kp 4) with any fast wind or CME arrival.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) is expected to be at background, but with a daily slight chance of rising in response to any large

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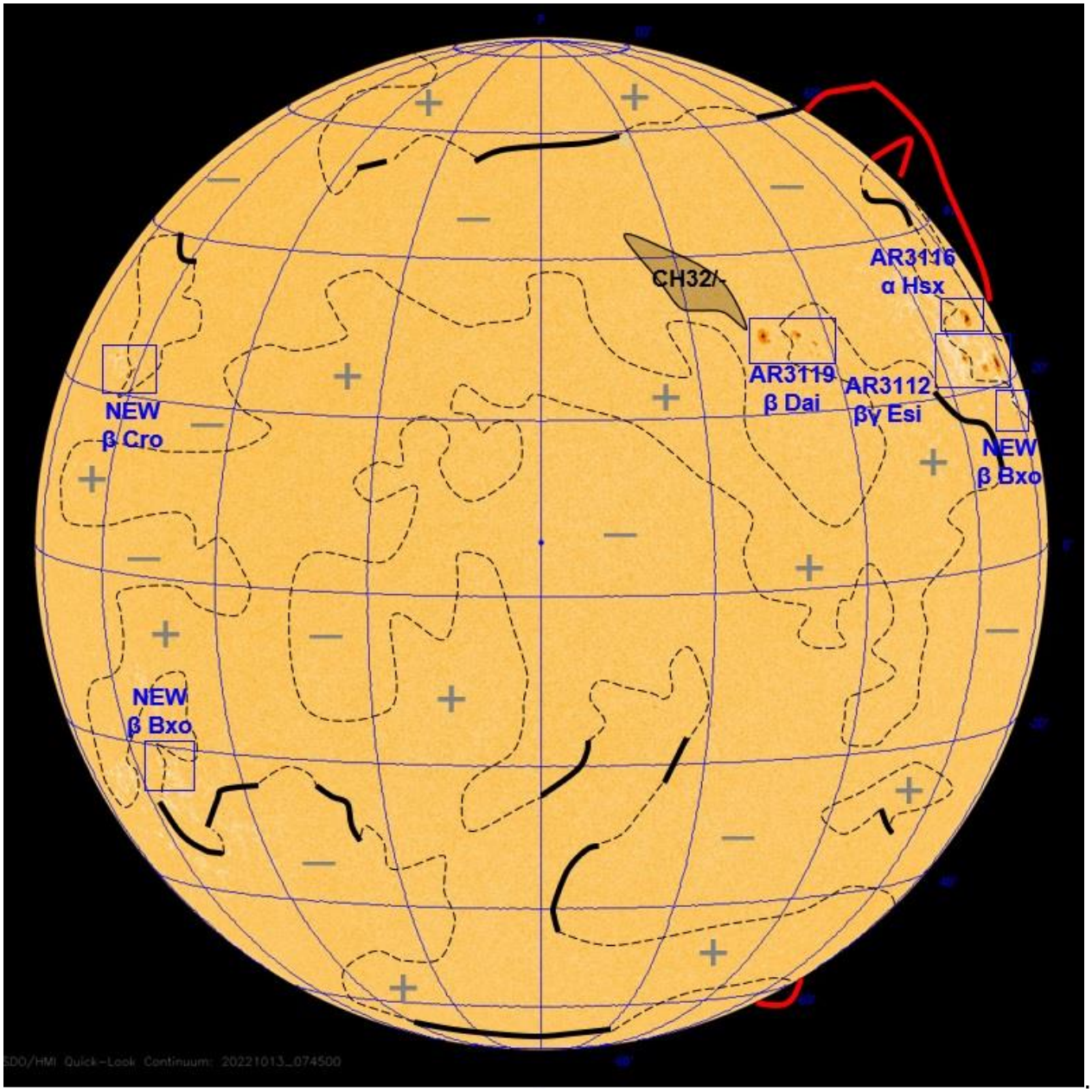
flares, primarily from the sunspots in the northwest quadrant. The high energy electron flux (greater than 2 MeV) is likely to persist at predominately High levels, but falling in response to any fast wind arrival late tomorrow or during day 3 (15th). The associated electron fluence is forecast to persist at Active levels, albeit with decreasing confidence, especially by day 4 (16th).

Figure 1. Solar Analysis Valid 13/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

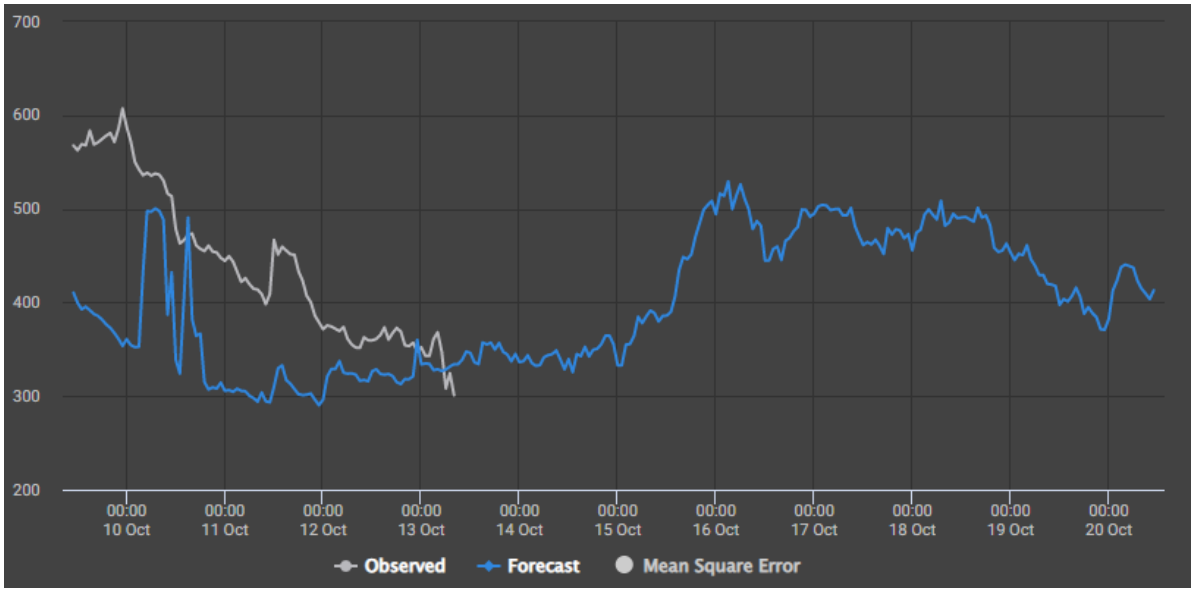
There is a weak CME, from a filament eruption on the 9th which is most likely to miss Earth, but may give a peripheral influence during day 2 (14th), and perhaps into day 3 (15th). A filament eruption from the southern centre disc early on the 13th has also produced a weak CME. Whilst the bulk of the material is likely to pass south of Earth's orbit, a glancing impact is possible towards the end of the period. However this has yet to be fully assessed for more exact timings of any arrival.

Solar winds are currently at background levels, with Earth embedded within an ambient slow wind environment. The next coronal hole fast wind enhancement is anticipated to be from CH32/- late day 2 or during day 3 (14th or 15th). Enlil has an earlier arrival through day 2, however this feature was larger in western extent on the previous rotation, and following persistence, this would be expected to arrive during day 3 (15th).

Mainly Quiet geomagnetic activity is expected with isolated Unsettled intervals. There is the chance of isolated Active intervals with the fast wind arrival mainly late day 2 (14th) or day 3 (15th), or from any passing CMEs influence.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	5	10	10
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Figure 2: Solar Wind Persistence Model



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Radio Blackouts - X-Ray Flares:

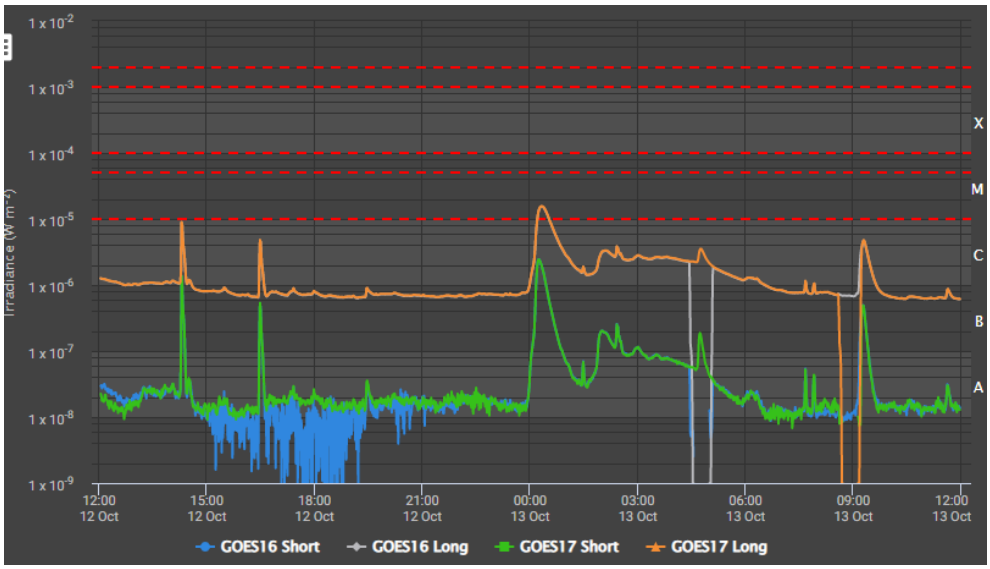
Activity is currently Moderate but expected to trend to be mainly Low, with the source of any recent M-flares being AR3112 Esi/Beta-gamma which is now approaching the northwest limb.

This sunspot has shown signs of simplification, with a trailing region fading, resulting into the reclassification as a smaller group. However AR3116 Hsx/alpha persists to the north of this region, whilst a further new emergent flux region has developed to its south. The combined effect of these could lead to some destabalisation of the region, and with significant magnetic looping visible, e.g. on SDO aia-304, then further M-flares remain possible from this region.

AR3119 Dai/Beta is also showing signs of decay, however this has produced a recent C4.7 flare, suggesting this also still has a small chance of producing low M-flares or similar. Further emergent flux regions towards the east limb remain relatively small and simple.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	30	30	15	10
Very Active	R3 to R5 X Class	No	2	2	1	1

Figure 3: GOES 16/17 X-ray flux



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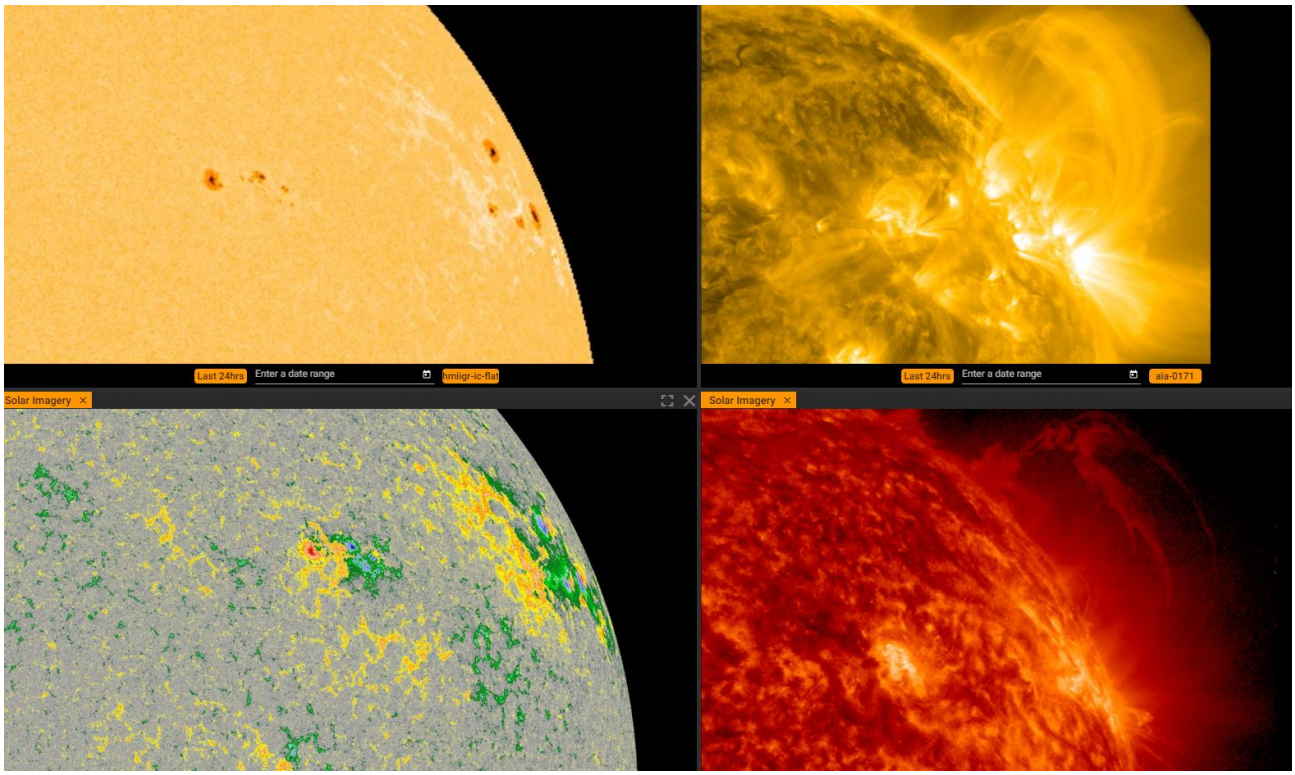
Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10MeV) as observed by GOES-16 is currently at background levels. Despite recent flaring over the last couple of days from AR3112, which is in a geoeffective location for proton storming, no observable increase in high energy proton flux has been observed. This sunspot continues to very gradually simplify, however due to its location and a couple of other active regions being present in the northwest disc, a very slight chance of approaching or exceeding the S1 threshold is maintained.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ S1	No	5	5	2	1
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: SDO Intensitygram (top left) and Magnetogram (bottom left) of the complex of sunspots in the NW disc (including AR3112/ AR3116 and AR3119). SDO aia-171 (top right) and aia-304 (top left) showing the surrounding magnetic looping of these regions.



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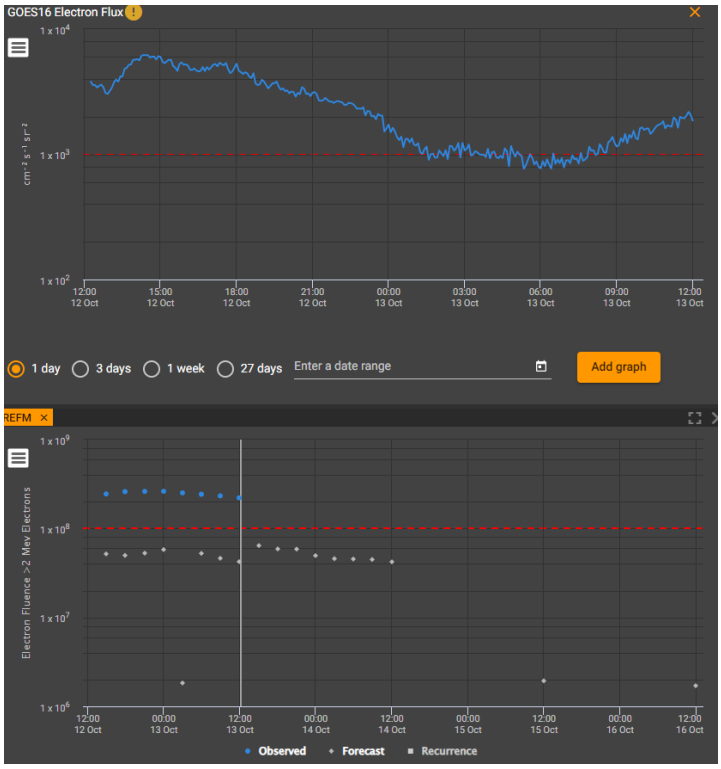
High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) as observed by GOES16 has been Moderate to High (above 1000 pfu). With no significant solar wind enhancement expected until the arrival of the fast winds of CH32/- late day 2 (14th) or during day 3 (15th) then these levels are expected to persist for much of the period, albeit with peak flux levels declining. There is the potential for drop out later day 2 or during day 3 (14th or 15th) from any fast wind arrival or peripheral CME influence, however this is low confidence.

The associated 24 hour fluence is forecast to persist at Active (above 1e8 integrated pfu), at least during days 1 and 2 (13th and 14th), and potentially beyond. Any flux drop out later in the period may bring a chance of fluence levels falling below the Active level by day 4 (16th). The current REFM forecast is currently producing poor guidance, and so should be disregarded, although this does show the potential for fluence values to gradually decline.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	Yes	100	95	70	50
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 5: GOES-16 Electron Flux and Fluence with REFM



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